

# Nuclear Physics

PHYS 4608 (Fall 2023)

**Course Instructor:** Emily Heath

**How to address me:** Professor Heath

**Gender Pronouns:** she/her/hers

**Email:** [Emily.Heath@Carleton.ca](mailto:Emily.Heath@Carleton.ca)

Note: If you have a question or would like to talk with me, you can send an email, visit me during student hours (see below), or approach me after lecture.

**Phone:** (613) 555-2829 ext. 4053

**Student Hours:** Monday & Wednesday, 1:00pm-2:00pm

## What are 'Student Hours'?

*Student hours are dedicated times through the week for the course instructor and TAs to meet with YOU. Pop in to introduce yourself, ask questions about the course, or discuss content from the course.*

*Note: If these times don't work for you, email me and we can arrange an alternate time to meet.*

**Office Location:** Room 2424, Herzberg Laboratories

**Class Location:** posted on Brightspace

**Class Times:** Monday & Wednesday, 10:05am-11:25am

**Prerequisites:** PHYS 3606 or PHYS 3608 or permission of the Department.

**Department/Unit:** Physics

**Course TA:** Benjamin Puzantian  
([BenjaminPuzantian@cmail.carleton.ca](mailto:BenjaminPuzantian@cmail.carleton.ca))

Note: For any questions about your assignment marks please send an email to the teaching assistant before contacting the instructor.

## Welcome to this Course!

In this course we will apply the concepts learned in your electricity & magnetism, modern physics and quantum mechanics courses towards understanding the properties of nuclei and how these properties transform through nuclear reactions or radioactive decay. The second part of the course will cover how radiation emitted by these processes interacts

with matter and the different types of detectors used to measure radiation. We will finish up with a discussion of how nuclear fission and fusion can be used in power generation.

### **Course level learning objectives:**

After completion of this course, students will be able to:

1. predict the properties of nuclei and nuclear states using the different nuclear models.
2. predict the final state of a nucleus after a nuclear decay or nuclear reaction using conservation laws.
3. explain the processes by which radiation interacts and how these interactions lead to a measured signal in different types of radiation detectors.
4. explain the practical aspects of power generation using nuclear fission and fusion.

### **Inclusive teaching statement:**

Science is for everyone. I am committed to fostering an environment for learning that is inclusive for everyone regardless of gender identity, gender expression, sex, sexual orientation, race, ethnicity, ability, age, class, etc. All students in the class, the instructor, and any guests should be treated with respect during all interactions. It is my hope that our class will support diversity of experience, thought, and perspective. I will continually strive to create inclusive learning environments and would therefore appreciate your support and feedback. I welcome emails or in-person communications to let me know your preferred name or pronoun. Please see the Faculty of Science Equity, Diversity, and Inclusion (EDI) statement: <https://science.carleton.ca/about/edi/>

### **Land Acknowledgement**

Here at Carleton University, it is important that we acknowledge that the land on which we gather is the traditional and unceded territory of the Algonquin nation.

## Community Guidelines

The following values are fundamental to academic integrity and are adapted from the International Center for Academic Integrity\*. In our course, we will seek to behave with these values in mind:

	As students, we will...	As a teaching team, we will...
<b>Honesty</b>	<ul style="list-style-type: none"> <li>Honestly demonstrate our knowledge and abilities on assignments and exams</li> <li>Communicate openly without using deception, including citing appropriate sources</li> </ul>	<ul style="list-style-type: none"> <li>Give you honest feedback on your demonstration of knowledge and abilities on assignments and exams</li> <li>Communicate openly and honestly about the expectations and standards of the course through the syllabus, and with respect to assignments and exams</li> </ul>
<b>Responsibility</b>	<ul style="list-style-type: none"> <li>Complete assignments on time and in full preparation for class</li> <li>Show up to class on time, and be mentally/physically present</li> <li>Participate fully and contribute to team learning and activities</li> </ul>	<ul style="list-style-type: none"> <li>Give you timely feedback on your assignments and exams</li> <li>Show up to class on time, and be mentally &amp; physically present</li> <li>Create relevant assessments and class activities</li> </ul>
<b>Respect</b>	<ul style="list-style-type: none"> <li>Speak openly with one another, while respecting diverse viewpoints and perspectives</li> <li>Provide sufficient space for others to voice their ideas</li> </ul>	<ul style="list-style-type: none"> <li>Respect your perspectives even while we challenge you to think more deeply and critically</li> <li>Help facilitate respectful exchange of ideas</li> </ul>
<b>Fairness</b>	<ul style="list-style-type: none"> <li>Contribute fully and equally to collaborative work, so that we are not freeloading off of others</li> <li>Not seek unfair advantage over fellow students in the course</li> </ul>	<ul style="list-style-type: none"> <li>Create fair assignments and exams, and grade them in a fair, and timely manner</li> <li>Treat all students equitably</li> </ul>
<b>Trust</b>	<ul style="list-style-type: none"> <li>Not engage in personal affairs while on class time</li> <li>Be open and transparent about what we are doing in class</li> <li>Not distribute course materials to others without authorization</li> </ul>	<ul style="list-style-type: none"> <li>Be available to all students when we say we will be</li> <li>Follow through on our promises</li> <li>Not modify the expectations or standards without communicating with everyone in the course</li> </ul>

<b>Courage</b>	<ul style="list-style-type: none"> <li>• Say or do something when we see actions that undermine any of the above values</li> <li>• Accept a lower or failing grade or other consequences of upholding and protecting the above values</li> </ul>	<ul style="list-style-type: none"> <li>• Say or do something when we see actions that undermine any of the above values</li> <li>• Accept the consequences (e.g., lower teaching evaluations) of upholding and protecting the above values</li> </ul>
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\* This class statement of values is adapted from Tricia Bertram Gallant, Ph.D.

## Online Community Expectations for Social Platforms

With the growing use of social platforms (e.g., Discord) on campuses, it is important to keep in mind that university codes of conduct still apply to the behaviours of students online. Please be considerate and respectful while engaging with peers and remember that we are all humans, and that your words matter. If any student witnesses or experiences harassment, I encourage you to reach out to me. Alternatively, you can contact [Ombuds Services](#) or [Carleton Equity and Inclusive Communities](#).

Online communities can be highly beneficial to students and can help to facilitate learning within the course. I encourage people to ask questions, learn from one another, and have open discussions about class material. That said, any acts of academic misconduct (i.e., cheating) will not be tolerated and will result in serious consequences ranging from a grade reduction to expulsion (*see [academic integrity violations](#)*).

- Examples of appropriate peer-to-peer sharing/learning vary from course to course. In this course appropriate peer-to-peer sharing includes: identifying the proper formula to use, identifying an incorrect or missing step in a person's work, brainstorming potential reasons behind a concept, suggesting helpful sites and videos for learning a concept, posting your own work showing only a specific step or process for illustrative purposes (note: this is very different from posting your work and solution for others to simply copy)
- Examples of unacceptable peer-to-peer sharing: Posting or sharing the answers, indicating which answers are correct on assignments, sharing links to solutions, posting your own complete work for a question/solution

## Learning Materials

**Textbook:**

Lilley, John (2021). *Nuclear Physics: Principles and Applications*. Wiley & Sons, 2001.

This book is available as an e-text at Carleton's MacOdrum library (no need to buy).

## Assessment in this Course

Research about learning strongly suggests that the most important factor in learning is doing the work of reading, writing, recalling, practicing, synthesizing, and analyzing. Learning happens best when people actively engage material on a consistent basis, and that is why we have high standards in this course. We are confident that, with appropriate effort, you **all** can meet those standards.

We also make an effort to reduce unintentional bias in grading by using methods such as grading assignments one question at a time (i.e., grading all of question 1 before grading any of question 2), grading anonymously, and using rubrics.

## Grade Breakdown

COMPONENT	GRADE VALUE
ASSIGNMENTS	40%
MIDTERM	15%
FINAL EXAM	35%
PRESENTATION	10%

## Assignments

There are 5 assignments in this course. Assignments will be posted and submitted on Brightspace. Hand-written solutions may be scanned or photographed for upload. The complete assignment must be uploaded as a single PDF file.

The lowest assignment mark will not count towards the final grade.

ASSIGNMENT	POSTED*	DUE*
1	Sept 13	Sept 25

2	Sept 25	Oct 4
3	Oct 4	Oct 16
4	Nov 1	Nov 13
5	Nov 20	Nov 29

\*These dates might be subject to change, in which case an announcement would be made on Brightspace.

### Late Assignment Penalties:

Late assignments will lose 10% per day. An assignment can no longer be submitted 7 days following its initial deadline.

## Midterm Exam

The midterm exam will be held in class on **Wednesday November 1<sup>st</sup>**. More details about the exam (eg. formula sheet) will be provided closer to that date.

Looking for help preparing for midterms? Student Academic Success Services (SASS) at Carleton offers course-targeted study groups and supports and the Science Student Success Centre (SSSC) provides help with study skills.

The final exam will take place during the final exam period.

## Presentation

During the last week of classes, students will give in-class presentations on an application of nuclear physics. Students can select from a list of topics that will be provided by the instructor or they can propose their own (subject to approval). A half-page presentation abstract (worth 2% of the final presentation grade) is due on November 20<sup>th</sup>.

## Feeling Sick?

If you feel very sick (e.g., fever, chills, stomach upset) do not come to class or campus. Contact the instructor if you will be unable to meet an assignment deadline due to illness.

## Mental Health

If you are struggling, please do not hesitate to reach out. I am happy to listen, and/or direct you to resources that might help. In terms of class, if you need extra help or missed a lesson, don't stress! Email me and we will set a time to meet. I'll work with you, I promise. Remember that Carleton also offers an array of mental health and well-being resources, which can be found [here](#).

## University Policies

In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100	B+ = 77-79	C+ = 67-69	D+ = 57-59
A = 85-89	B = 73-76	C = 63-66	D = 53-56
A- = 80-84	B- = 70-72	C- = 60-62	D- = 50-52
F = <50			
WDN = Withdrawn from the course			
DEF = Deferred			

## Academic Accommodations, Regulations, Plagiarism, Etc.

Carleton University is committed to providing access to the educational experience in order to promote academic accessibility for all individuals.

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University. More information can be found at: <https://students.carleton.ca/course-outline/>

University rules regarding registration, withdrawal, appealing marks, and most anything else you might need to know can be found on the university's website, here:

<https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/>

## Academic Accommodations for Students with Disabilities

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the [Paul Menton Centre website](#).

## Addressing Human Rights Concerns

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at [equity@carleton.ca](mailto:equity@carleton.ca).

## Religious Obligations

Please contact me with requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF, 2.1 MB\)](#).

## Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: <https://carleton.ca/sexual-violence-support/>

## Accommodations for Missed Work

Carleton recognizes that students may experience unexpected, temporary incapacitation (i.e., illness, injury, or extraordinary circumstances outside of a student's control). As a



result, Carleton has put into place a protocol for students to apply for accommodations using a self-declaration form in the event of missed work. The form can be found at: <https://carleton.ca/registrar/wp-content/uploads/self-declaration.pdf> Note that these forms should be used for short-term concerns related to missed work; if you are experiencing chronic, ongoing challenges which necessitate a broader solution, I recommend reaching out to the Paul Menton Centre and/or the Care Support team.

## For Pregnancy

Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF, 2.1 MB\)](#).

## Accommodation for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the [Senate Policy on Accommodation for Student Activities \(PDF, 25KB\)](#).

## Academic Integrity

Academic Integrity is upholding the values of honesty, trust, respect, fairness, responsibility, and courage that are fundamental to the educational experience. Carleton University provides supports such as academic integrity workshops to ensure, as far as possible, that all students understand the norms and standards of academic integrity that we expect you to uphold. Your teaching team has a responsibility to ensure that their application of the Academic Integrity Policy upholds the university's collective commitments to fairness, equity, and integrity.

(Adapted from [Carleton University's Academic Integrity Policy](#), 2021).

**Examples of actions that do not adhere to Carleton's Academic Integrity Policy include:**

- Plagiarism
- Accessing unauthorized sites for assignments or tests
- Unauthorized collaboration on assignment and exams
- Using artificial intelligence tools such as ChatGPT when your assessment instructions say that it is not permitted

Please review the checklist [linked here](#) to ensure you understand your responsibilities as a student with respect to academic integrity and this course.

## Sanctions for Not Abiding by Carleton’s Academic Integrity Policy

A student who has not upheld their responsibilities under Carleton’s Academic Integrity Policy may be subject to one of several sanctions. A list of standard sanctions in science can be found [here](#).

Additional details about this process can be found on the [Faculty of Science Academic Integrity website](#). Students are expected to familiarize themselves with and follow the Carleton University [Student Academic Integrity Policy](#). The Policy is strictly enforced and is binding on all students.

## Student Rights & Responsibilities

Students are expected to act responsibly and engage respectfully with other students and members of the Carleton and the broader community. See the [7 Rights and Responsibilities Policy](#) for details regarding the expectations of non-academic behaviour of students. Those who participate with another student in the commission of an infraction of this Policy will also be held liable for their actions.

## Student Concerns

If a concern arises regarding this course, **your first point of contact is me**: Email or drop in during student hours and I will do my best to address your concern. If I am unable to address your concern, the next points of contact are (in this order):



**Note:** You can also bring your concerns to [Ombuds services](#).

## Assistance for Students

Writing Services: <http://www.carleton.ca/csas/writing-services/>

Peer Assisted Study Sessions (PASS): <https://carleton.ca/csas/group-support/pass/>

Math Tutorial Centre: <https://carleton.ca/math/math-tutorial-centre/>

Science Student Success Centre: <https://sssc.carleton.ca/>

Week	Monday	Tuesday	Wednesday	Thursday	Friday
<b>September</b>					
1	4	5	<i>Fall term begins</i> <i>Lecture 1</i> 6	7	8
2	<i>Lecture 2</i> 11	12	<i>Lecture 3</i> <i>Assign #1 posted</i> 13	14	15
3	<i>Lecture 4</i> 18	19	<i>Lecture 5</i> 20	21	22
4	<i>Lecture 6</i> <i>Assign #1 due</i> <i>Assign #2 posted</i> 25	26	<i>Lecture 7</i> 27	28	29
<b>October</b>					
5	<i>Lecture 8</i> 2	3	<i>Lecture 9</i> <i>Assign #2 due</i> <i>Assign #3 posted</i> 4	5	6
6	<i>Statutory holiday</i> <i>no classes</i> 9	10	<i>Lecture 10</i> 11	12	13
7	<i>Lecture 11</i> <i>Assign #3 due</i> 16	17	<i>Lecture 12</i> 18	19	20
<b>No Classes</b>	<i>Fall Break</i> 23	<i>Fall Break</i> 24	<i>Fall Break</i> 25	<i>Fall Break</i> 26	<i>Fall Break</i> 27
<b>November</b>					
8	<i>Lecture 13</i> 30	31	<i>Midterm exam</i> <i>Assign #4 posted</i> 1	2	3
9	<i>Lecture 14</i> 6	7	<i>Lecture 15</i> 8	9	10
10	<i>Lecture 16</i> <i>Assign #4 due</i> 13	14	<i>Lecture 17</i> 15	16	17
11	<i>Lecture 18</i> <i>Abstract due</i> <i>Assign #5 posted</i> 20	21	<i>Lecture 19</i> 22	23	24
12	<i>Lecture 20</i> 27	28	<i>Lecture 21</i> <i>Assign #5 due</i> 29	30	1
<b>December</b>					
13	<i>Presentations</i> 4	5	<i>Presentations</i> 6	7	<i>Review lecture</i> 8